Appendix A

GLOSSARY OF TRAFFIC SIGNAL TERMS

Signals
Traffic Signal—Any power-operated traffic control device, except a sign, by which traffic is warned or is directed to take some specific action.
Traffic Control Signal—A traffic signal which, through its indications, alternately directs traffic to stop and permits it to proceed.
Fixed-Time Signal—A type of traffic control signal which directs traffic to stop and permits it to proceed in accordance with a predetermined time schedule.
Traffic-Actuated Signal—A type of traffic control signal in which the intervals are varied in accordance with the demands of traffic as registered by the actuation of detectors or push buttons.
1. Semi-traffic-actuated signal—A type of traffic-actuated signal in which means are provided for traffic actuation on one or more but not all approaches to the intersection.
2. Full traffic-actuated signal—A type of traffic-actuated signal in which means are provided for traffic actuation on all approaches to the intersection.
3. Speed control signal—A type of traffic control signal in which means are provided for traffic actuation on some or all approaches and which provides go indications in such a manner that vehicle speeds on one street are limited to a preselected maximum value.
Stop Signal—A flashing red signal having the same function as a Stop sign.
Caution Signal—A flashing yellow signal having the same general function as a warning sign.
Flashing Beacon—A section of a standard traffic signal head, or a similar type device, having a yellow or red lens in each face, which is illuminated by rapid intermittent flashes.
Signal Head—An assembly containing one or more signal faces which may be designated accordingly as one-way, two-way, three-way, four-way, or multi-way.
Signal Face—That part of a signal head provided for controlling traffic in a single direction.
Signal Indication—The illumination of a traffic signal lens or of a combination of several lenses at the same time.
Optical Unit—An assembly of reflector, receptacle, redirecting cover glass, and door, with the necessary supporting parts, to be used with a light source for providing a single signal indication.
Redirecting Cover Glass, or Lens—That part of the optical unit which redirects the light coming from the reflector. It is commonly referred to as a lens or roundel.
Signal Support—The physical means whereby a signal head is supported in a particular location.
Signal Installation—All of the equipment and materials involved in the signal control of traffic at one intersection.

Controllers
Controller—A complete electrical mechanism for controlling the operation of traffic control signals, including the timer and all necessary auxiliary apparatus mounted in a cabinet.
Auxiliary Manual Controller—A separate and distinct manual controller attached to an automatic controller by means of which the traffic control signals may be operated by hand when the automatic timer is disconnected.
Fixed-Time Controller—An automatic controller for supervising the operation of traffic control signals in accordance with a predetermined fixed-time cycle and division thereof.
Synchronous Motor Controller—A controller operated by a motor that will maintain a constant speed governed by the frequency of the power supply circuit.
Induction Motor Controller—A controller operated by a motor having variable speed dependent upon the line voltage of the power supply circuit.

Synchronous Supervisory Mechanism—An auxiliary synchronous motor applied to an induction motor-driven traffic controller to cause such controller to keep in step with the constant frequency of the power supply circuit. Use of a master controller to maintain definite time relationships of all such controllers in the signal system and to operate the remote signal shutdown, flashing indications, total time cycle change, and other features of operation.

Master Controller—A synchronous motor-driven controller, or an induction motor-driven controller provided with a synchronous supervisory mechanism, designed to supervise the operation of all interconnected controllers to maintain definite time relationships of all such controllers in the signal system and to operate the remote signal shutdown, flashing indications, total time cycle change, and other features of operation.

Secondary Controller—An automatic controller for operating the traffic control signals at an intersection under the supervision of a master controller.

Local Controller—A controller for operating traffic control signals at an intersection (or two or three proximate intersections) which may be isolated or included in a signal system.

Traffic Actuated Control—An electrical mechanism for supervising the operation of traffic signals in accordance with the varying demands of traffic as registered by the controller by detectors or push buttons.

Traffic Actuated Speed Control—A type of traffic-actuated control designed to provide signal indications that have the effect of limiting the speed of approaching vehicles.

2. Intersection Speed Control—A type of traffic-actuated speed control in which speed control features are combined with or are superimposed upon full traffic-actuated control at intersections.

3. Nonintersection Speed Control—A type of traffic-actuated speed control designed solely for limiting the speed of approaching vehicles at road locations other than intersections.

Timer—The automatic timing mechanism in a controller, including all dials for setting, interval, signal operation, signal stop, and offsets, switches, and devices for controlling the operation of signal circuit contacts, motors, gears, and camshafts, and, in the master controller, the total time cycle change and resynchronization or reset mechanisms.

Double Dial Timer—An automatic timer equipped with two timing dials mechanically or electrically interconnected so that it is possible to set up and remotely select any one of the three timing programs of all intervals and offsets.

Triple Dial Timer—An automatic timer equipped with three timing dials mechanically or electrically interconnected so that it is possible to set up and remotely select any one of three timing programs of all intervals and offsets.

Detectors

Detector for Traffic Actuation (general definition)—A device by which vehicles, streetcars, trolley buses, or pedestrians are enabled to register their presence with a traffic-actuated controller.

Pressure-Sensitive Vehicle Detector—A detector installed in the roadway capable of being actuated by the pressure of a vehicle passing over its surface. Also known as Road Surface Detector. Also known as Road Surface Detector.

Light-Sensitive Vehicle Detector—A detector installed in or near the roadway capable of being actuated by a vehicle passing over its surface. Also known as Road Surface Detector.

Sound-Sensitive Vehicle Detector—A detector installed outside in or near the roadway capable of being actuated by the pressure of a vehicle passing over its surface. Also known as Road Surface Detector.

Streetcar Detector—A detector installed in or near the roadway capable of being actuated by a streetcar passing over its surface. Also known as Road Surface Detector.

Vehicular Flow Detector—A detector capable of being actuated by vehicles proceeding in the same direction.

Vehicular Flow Detector—A detector capable of being actuated by vehicles proceeding in the same direction.

Pedestrian Detector—A detector, usually of the push-button type, installed near the roadway capable of being operated by hand.

Signal Operation

Time Cycle—The number of seconds required for one complete revolution of the timing dial or complete sequence of signal indications.

Color Sequence—A predetermined order of appearance of signal color indications during successive intervals within a total time cycle.

Traffic Phase (Traffic Movement)—A part of the time cycle allocated to any traffic movement receiving the right-of-way or to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals.

Vehicular Phase (Vehicular Movement)—A traffic phase allocated to vehicular traffic.

Pedestrian Phase (Pedestrian Movement)—A traffic phase allocated exclusively to pedestrian traffic.

Interval—Any one of the several divisions of the time cycle during which signal indications do not change.

Clearance Interval—The time of display of the signal indication following the right-of-way interval (generally yellow).

Interval Sequence—The order of appearance of signal indications during successive intervals of a cycle.

Initial Portion—The first part of the green interval which is timed-out and actuated by a traffic-actuated controller before the extendible portion of the interval takes effect.

Extendible Portion—The right-of-way interval following the initial portion.

Unit Extension—The minimum time, during the extendible portion, for which the right-of-way must remain on any traffic phase following an actuation on that phase, but subject to the extension limit.

Extension Limit—The maximum time for which actuations on any traffic phase may remain in the right-of-way after actuation on another traffic phase.

Minimum Portion—In semi-traffic-actuated control, the shortest time for which the right-of-way shall be given to the approaches not having detectors.


Flashing Feature—A relay or other device installed in a controller which when energized from a remote point or by an automatic time switch continues normal operation and causes the flashing of any predetermined combination of signal lights.

Emergency Feature—A relay or other device installed in a controller which when energized from a remote point continues the normal signal operation and displays special signal indications for the movement of high-speed fire apparatus, emergency vehicles, etc.

System Operation

Signal System—Two or more signal installations operating in coordination.

Simultaneous System—A signal system in which all signals along a given street always give the same indication at the same time.

Alternate System—A signal system in which alternate signals, or groups of signals, give opposite indications to a given street at the same time.

Control System—A signal system in which the various signal faces controlling a given street give Go indications in accordance with a time schedule to permit (as nearly as possible) continuous operation of groups of vehicles along the street at a predetermined rate of speed, which may vary in different parts of the system.

Flexible Progression System—A signal system in which the intervals at any signal may be independently adjusted to the traffic requirements at the intersection, and in which the Go indications at separate signals may be started independently at the instant that will give the maximum efficiency.

Fixed Time System—The time in seconds elapsed between the passing of the first and the last possible vehicle in a group of vehicles moving in accordance with the designed speed of a progressive signal system.

specified Operation—A specified timing relationship of the Go indication between controllers in a system of traffic control signals in accordance with a predetermined timing diagram.

Split Time—In a signal system, the interval in seconds between a certain instant arbitrarily used as a time reference base (recursing each cycle) and the start of the Go indication at a given signal in that system.

Schedule—An adjustment mechanism for setting up the timing arrangement of the start of the Go indication.

Double Offset—An adjustment mechanism providing for the setting up of two timing arrangements of the start of the Go indication, either of which may be selected manually or by means of an electric time switch.

Triple Offset—An adjustment mechanism providing for the setting up of three
timings arrangements of the start of the Go indication, any one of which may be selected manually or by means of an electric time switch.

Offset Dial—A calibrated dial on an automatic timer equipped with adjustment devices by means of which it is possible to set any desired offset of the beginning of the Go signal indication.

Interval Dial—A dial on an automatic timer, calibrated in 1 percent steps, and equipped with adjusting devices by means of which it is possible to divide the total time cycle into the required number of intervals and set up the offset and interlock.

Automatic Reset—A mechanism applied to a traffic signal controller by means of which the timing of the beginning of the Go indication is checked automatically once each total time cycle.

Out-of-Step—That condition of a traffic control signal installation belonging to a signal system which, when its operation does not possess the intended relationship to the system.

Recoordination—Restoration of the intended interrelationship of operation of signals in a signal system.
Wartime shortages as well as war-stimulated technical advances have resulted in changes in the basic materials for sign manufacture. Various types of fiber board, waterproof (resin-bonded) plywood, laminated plastics, and other plastic products, have been found to give satisfactory service under suitable conditions. Some of these substitutes, it may be assumed, have not only saved money, but also have given a better and more attractive choice between different available materials depends on cost, appearance, and durability. Excessive cost for "permanence" is not justified where damage by violence (accident or vandalism) may result. A fiber board may require frequent replacement. On the other hand, a low first cost may be poor economy. Where signs are to be quite temporary, however, as for an emergency detour, it may suffice to paint them on a water-resistant cardboard.

Metal Signs

For metal sign plates, sheet iron or steel is commonly used, though sheet aluminum has offered some competition in recent years. Sheet steel should be at least 18 gage thickness, U.S. Standard. For plates 24 inches or larger in any dimension, 16 gage metal is preferable for greater strength. Aluminum should be 0.024 to 0.031 inch in thickness.

For unembossed sign plates, having no stiffening bead around the edge, a somewhat heavier gage is desirable. For steel sign plates, ordinary commercial flat black sheets are satisfactory. If galvanized plates are desired, they may be required to conform to the American Society for Testing Materials Standard Specifications A 530, Class D, ordinary coated sheets for general utility, or U.S. Federal Specification QQ-T-716, for galvanized steel sheets, Class D1 or D2.

Aluminum sheet comes in various grades of hardness. A hard temper is desirable, but if the plate is to be embossed it should not be so hard as to crack or tear. Fully soft annealed sheet should be avoided in any case. Aluminum sheet should conform to the American Society for Testing Materials Standard Specifications A 90. Alloy A5 or A1, and SS, respectively, of the Aluminum Company of America, or to U.S. Federal Specification QQ-A-514b or QQ-A-359b, for aluminum plate and sheet.

In embossing it is the detail of the design should be raised from the background of the design not less than 0.100 inch nor more than 0.125 inch. The finished embossing should conform to the lines of the working drawings and should be clear and even in outline and free from cracks and tears. The entire sign should be free from twist or buckle, and the background should be substantially a plane surface.

A suitable alloy for cast aluminum signs is covered by the American Society for Testing Materials Standard Specifications B 26-48T, Alloys S1 and S2. Alloy 43, Aluminum Company of America, may also be specified.

A very important step in the fabrication of sheet metal is the preparation of the surface before painting, to protect it from corrosion and to improve the adherence of the paint. Hot-dip phosphate treatments are known to give excellent results in enhancing the protective value of paints, on both plain and galvanized steel surfaces, and certain cold-dip chromate and phosphate treatments have also proved satisfactory. Treatments of both types are available under several proprietary names.

An aluminum surface should be treated with a dilute aqeous solution of phosphoric acid (generally a proprietary process) or with a suitable alkaline cleaner followed by a hot water rinse or treatment in a suspension of then be given a coat of zinc chromate primer. A lead primer should never be used on aluminum.

Painted metal signs should have a priming coat and at least one additional coat on the back and two additional coats on the face. A good grade of baking enamel should be used, having a low-gloss finish to avoid glaring reflections.

Wooden Signs

Wooden signs, other than plywood, should be of yellow poplar, redwood, white pine, yellow pine, fir, or cypress, kiln dried, grading one face clear, other side free from loose knots, large pitch pockets, or other harmful defect. They should have tongue-and-groove joints parallel with the grain of the wood and running in the longer dimension of the finished sign. The glue must be of a waterproof type. Signs should be reinforced with two battens securely fastened to each separate member of the sign. Sign boards and battens should be of 1-inch stock, surfaced on all sides, and the face of the finished board must be a smooth plane surface.

Plywood must be of the waterproof resin-bonded type. Three-ply fir plywood, Douglas Fir Plywood Association, is adequate for most standard signs, but a greater thickness should be used for large panels.

For wooden signs a standard exterior linseed oil paint should be used rather than an enamel. Federal Specifications TT-F-40 and TT-F-101a, for white paint, and TT-F-98 for yellow paint are applicable.

Porcelain Enamel Signs

Vitrified or porcelain enamel signs have high durability if not damaged by accident, but they must be protected against cracking. Bolt holes should be grommeted to prevent chipping. Model specifications for porcelain enamel signs may be obtained on application to the Porcelain Enamel Institute, 100 Vermont Avenue, N.W., Washington 5, D.C.

Reflecting Elements

The efficiency of reflecting elements depends on their optical characteristics and on their durability under weathering. The brilliance of a reflector button or reflecting coating cannot be measured as a single value. The intensity of the light reflected from a spot source varies with:

1. The divergence angle, i.e., the angle between the incident light and the light reflected to the observer. A reflector button or a reflecting coating (except the embossed mirror type) is designed to reflect the incident light in a concentrated or focused beam directly toward its source. Actually there must be enough divergence in the reflected beam to reach the center of a driver's vision at all pavement positions above the headlamp beam. Any wider spread of the reflected light is largely wasted. For a long-range brilliance the divergence angle may be very small, but if the brilliance is to be maintained at 20 feet from the source, a wider angle is necessary to avoid losing brilliancy as a result of being scattered from the surrounding surface. Typical tests for reflecting elements require measurement at divergence angles of $1/4$ and $2$ degrees (approximately $10\%$ and $42$ degrees, respectively, at 100 feet).

2. The entrance angle, i.e., the angle between the ray of incident light and a perpendicular to the front surface of the sign face or reflector. A reflectorized sign or marker is not always in a plane at 90 degrees to approaching traffic. A reflector button or reflecting coating therefore must be capable of functioning without serious loss of brilliancy within a fairly wide variation in entrance angle. Here again the need for a wide entrance angle is greatest at close range, when the passing vehicle is at one side of the reflector, not approaching it head on. Typical reflector tests include measurements of entrance angles of 10, 20, and 30 degrees.

3. The inherent reflecting qualities of the surfaces involved, or the accuracy or consistency with which the optical system can be made to function. The over-all efficiency of different reflectors necessarily varies. Two reflectors of similar optical characteristics may perform at different levels of brilliancy, due to differing light losses in reflection and reflection within and at the face of the reflector. Reflecting devices generally tend to lose less efficient with weathering.

Standard specifications for reflector buttons and reflecting coatings for traffic control devices have not been agreed upon, primarily because of a lack of accepted data on the exact what performance is needed. Excessive cost can result in destroy sign legibility as effectively as insufficient brilliancy. For certain signs, like the Stop sign, however, conspicuous visibility may be more important than legibility.

Specifications for delineators and hazard markers are subject to the same requirements as those for reflecting elements in signs, except that high brilliancy need be considered only as a possible source of dazzle, not as a factor in legibility. A simple technique for measuring the brilliancy of reflecting elements by comparison with a calibrated standard is that adopted by the Society of Automotive Engineers as applicable to motor-vehicle reflectors, and published in the SAE Handbook as "Reflector Reflectors, SAE Recommended Practice." A somewhat more elaborate method is that developed by Dr. R. Kingslake, of the University
of Rochester, described in the Journal of the Optical Society of America, vol. 28, No. 9, September 1938. This has been used in a number of laboratories as a standard test for sign reflectors.

Complete specifications for reflector buttons should cover materials, dimensions, type of mounting and fittings, lenses and reflectors, optical performance, and durability. Tests for durability usually include intensive corrosion and weathering exposure, such as salt spray and sunshine, and are intended to reveal any weakness in the seal protecting the reflecting surfaces.

In the case of reflector hazard markers, color must also be specified. For reflecting coatings, in addition to requirements as to optical characteristics, it is necessary to specify color, weather resistance (including ultraviolet light exposure for paints and plastic materials), and method of attachment to the sign plate.

Reflector buttons and reflectors coated by well established manufacturers, however, can usually be purchased without detailed specifications, as their performance can be guaranteed by the maker. A practical approach will involve a test comparison of several products as a basis for selection before purchase.

Sign Colors

Where yellow is specified for signs, it should conform with the color cards for "highway yellow," available from the Public Roads Administration. This is a chrome yellow, normally produced as a lead chromate pigment. There are no similar standards available for the red and green required on parking signs.

Many red pigments have a tendency to fade, but a strong, clear red of good durability can be obtained with a toluene red pigment. Green should be a bright chrome green, normally a combination of lead chrome and insoluble Prussian blue.

Sign Posts and Mounting

Posts for sign mounting may be of any material that will give good and economical service, and local availability is usually an important consideration. Various designs of steel sections or pipe, installed by driving into the ground, have been commonly used.

For channel sections weights of from 1½ to 2½ pounds per linear foot have been specified, depending on the strength required. The usual commercial grades of bar steel may be assumed to be satisfactory for sign posts, but if a steel specification is desired, Federal Specification QQ-T-711 is suggested. Pipe should be anchored to prevent turning.

Steel posts should be galvanized or well painted to prevent rusting.

Wooden posts, treated with a preservative, have given good service. They should be at least 4 inches square in cross section, depending on the size of the sign to be mounted. Concrete posts, with suitable reinforcing steel, are also good, though less adaptable to varied bolt-hole requirements.

All posts should be of sufficient length to set rigidly in the ground, but they should not generally extend above the signs or sign assemblies mounted upon them.

The variety of sign sizes and layouts makes it impracticable to maintain a uniform spacing of bolt holes in the sign plates. Standard posts, to accommodate flexibly any sign or assembly of signs, should accordingly have holes punched or drilled at the posts through the upper portion of their length. Holes near the ground level should be avoided, as they weaken the post where maximum strength is required. Wooden posts can, of course, be drilled in the field to fit any sign. Concrete posts cannot practically be made with a hole spacing of much less than 3 inches, center to center. Posts with holes on 6-inch centers will fit all warning signs illustrated in this manual, and those with holes on 3-inch centers will also fit most of the regulatory signs.

Signs should be mounted with rust-resistant bolts and washers, to prevent dislocation of the sign face in case of vandalism. The Institute of Traffic Engineers recommends for use under the bolt head. Experience may indicate a need in some areas for special vandal-resisting bolt fittings.

PAVEMENT MARKINGS

Much research has been devoted to the development of materials for pavement markings, and particularly to the improvement of "traffic paint."

Paint

Pavement-marking paint must not only be capable of taking the hardest kind of wear under severe exposure to weather, but it must also dry very rapidly and flexibly. As a typical specification, there may be cited Federal Specification TT-P-115, for white and yellow traffic paint. This gives wide latitude in composition, but requires that quality, as determined by abrasion and accelerated weathering tests, shall be at least equal to that of a "comparison paint" of a prescribed formula. Some highway departments have been purchasing their paint on more definitely on a performance basis. Bidders are required to submit samples, which are to be applied at test stripes on a pavement. The award is made after comparing durability, appearance, and price. The Ohio State Department of Highways has developed an excellent specification of this type.

For yellow pavement markings the specified color is that shown in the color cards for "highway yellow," available from the Public Roads Administration.

Reflectorized Markings

The most common type of reflectorized pavement marking is that in which small glass spheres are incorporated in a painted surface, either by scattering them into the wet paint immediately after application, or by mixing them in the paint before application. Glass-bonded paints are available under several trade names, and, to assure satisfactory materials and performance, it is suggested that the choice in purchase be based on performance tests for the paint.

Unit Pavement Markers

No standard specifications, other than the general requirements of section 122 of this manual are available for the types of markings made up of small, flat or slightly rounded units on the pavement surface. Particular attention should be given to the adequacy of the means used for anchoring or cementing these units to the pavement, and to their durability under traffic.

TRAFFIC SIGNALS

Traffic signal specifications must cover the signal head units, the controllers, the detectors (if traffic-actuated), and the accessory wiring and fittings.

Signal Heads

The standard specification for signal heads is that in Technical Report No. 1 of the Institute of Traffic Engineers, Adjustable Face Traffic Control Signal Head Standards. It is approved as an American Standard (D 101-1942) by the American Standards Association.1 This covers the design and material for housings, lenses, reflectors, and lights, giving particular emphasis to color, intensity, and candle-power distribution of the signal lights.

Signal Controllers

Specifications for signal controllers must be drawn to cover the requirements of any particular installation or system of signals. It is generally desirable to provide for greater flexibility than is regarded as immediately necessary, both to permit subsequent adjustment of changing conditions, and to assure a factor of safety in the form of reserve circuits. For fixed-time signal controllers the authoritative specification is that in Technical Report No. 2 of the Institute of Traffic Engineers, Pre-Hened, Fixed Cycle Traffic Signal Controllers, approved as an American Standard (D 111-1948) by the American Standards Association.2

Traffic-actuated signal controllers must meet many of the specifications of the standard cited in the preceding paragraph, but must in addition be designed to receive impulses from one or more detectors, and to respond to those impulses on a prearranged system of priorities. Since many installations of traffic-actuated equipment must be especially designed to deal with irregular traffic conditions, the requirements for the controllers will vary accordingly. The advice of manufacturers will be valuable in planning a given installation, and in drawing specifi- cations for the signal face and other units thereof. The Institute of Traffic Engineers has in preparation a standard specification for traffic-actuated signal controllers, similar to its specification for fixed-time controllers.

Detectors are to be regarded as a feature of the signal controller, and specifications should be drawn accordingly.

1 Obtainable from the Institute of Traffic Engineers, Stratton Hall, New Haven, Connecticut, or from the American Standards Association, 70 East 45th Street, New York 17, N. Y. (price, 35 cents).
Wiring and Fittings

Cables and wiring of traffic signals must, of course, depend on the type of installation (e.g., whether underground or overhead), the number of circuits required, and the electrical load to be carried. Suggestions are to be found in section 154 of this manual, and in the Traffic Engineering Handbook, published jointly by the Institute of Traffic Engineers and the National Conservation Bureau, but any specification must be based on sound electrical engineering practice. The signal manufacturer, the electrical utility company, or the city electrician can be consulted for recommendations. Recent developments in insulation have simplified the installation of underground wiring. Specifications for numerous types of cables to meet varied requirements have been approved by the American Society for Testing Materials, and there are several applicable Federal Specifications.

Although a color coding of the conductors in all cables is recommended, there is as yet no generally accepted code for signal circuits. A suggested code may be found in the Traffic Engineering Handbook.

Conduits and fittings, as needed, should be of standard approved designs. Recommendations of the signal manufacturer will be a useful guide in their selection. Practical suggestions are also to be found in the Traffic Engineering Handbook.

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